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BENCHMARK: A Project to Identify and Improve Levels of Health and Productivity in Ontario Beef Cow-Calf Herds

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Monitoring animal disease and production is an extremely important activity for veterinarians who provide herd health management services to their clients. Only in this way will there be concrete information on where the herd was and where it is as well as data on which predictions can be based about where the herd is going.

Most diseases have both a clinical and a subclinical phase; the latter is often the more frequent and important of the two. A variety of methods are, or soon will be, available to detect the presence of subclinical disease. These range from specific serologic, microbiologic, or hormonal tests on animals to the so-called multiphasic screening for the detection of metabolic abnormalities.

In recent years, however, the monitoring of production has been shown to be the best overall indicator of the health of an animal or a herd. Identifying deficits in production highlights problem areas whether the deficit is from disease, a ration imbalance, or mismanagement. Further, such monitoring of production emphasizes the aspect of the farm that is correlated with economic performance and allows the veterinarian and herd owner/manager to put disease in a realistic perspective.

When the Ontario Ministry of Agriculture and Food announced its Beef Herd Improvement Program (BHIP), the time seemed ripe for gathering data on the productivity of Ontario beef herds. In addition, discussions with veterinarians made it clear that, in spite of their many diagnostic and pharmacological tools with which to help farmers manage herds better, the absence of production data made it difficult to determine what type of remedy(ies) to apply to a specific farm.

Now, nearing the end of the BENCHMARK project, we are struck by the enormous amount of data collected. Along the way, we have gained considerable insight into the advantages, and difficulties, of monitoring beef herds. The help of collaborating farmers, veterinarians, Red Meat Advisors, Agricultural Representatives, and others has been much appreciated.

This is perhaps the largest and most far-reaching study of the beef industry anywhere. Few have attempted analyses on this scale, and the project fits well with others involving large-scale monitoring of disease and production.

This coming fall, we will conduct our first continuing education program arising from the results of the project. In addition to the facts and concepts gathered in this study, we will demonstrate software which simplifies the monitoring process.

In compiling the data in this project, Dr. David Alves examined the factors influencing calf survival and productivity, Dr. Neil Anderson examined the effects of weaning and yearling weight in heifers on their future performance, and Dr. John McDermott studied aspects of the adult herd. Their analyses will continue during 1989, and updated information will be released as it becomes available.

BENCHMARK also provided us with a core of farms through which to investigate the biologic and economic effects of preconditioning. The results of these studies will be forthcoming this summer.

Table 1: Flow chart to pattern BENCHMARK response from 1986 to 1988

1444 herds	**Target Population** (more than 24 cows and enrolled in BHIP)
300 herds	(a formal random sample stratified by region of Ontario).
100 herds	A formal random subsample of the 300 herds to be followed intensively. This approach was abandoned due to only a 50% mail survey response in the 200 (300-100) herds to be followed extensively.
75	responded "yes"
28	responded "no" (75/(100-7)) = 80.6% response
7	sold herd
181	responded "yes"
66	responded "no"
53	out of study (45 sold, 4 dead, 4 unable to contact) (181/(300-53)) = 73.3% response
181	herds
+11	11 of the 181 herds with 2 breeding groups
192	**Study Population** — breeding groups visited and followed intensively in 1986.
	3 breeding groups sold all cows before the 1987 calving season
	3 breeding groups were excluded due to poor information[a]
186	breeding groups followed intensively in 1987

a. for analyses of reproductive measures 8 breeding groups had poor information, leaving 181 for intensive followup in 1987.

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STUDY POPULATION AND SAMPLE SELECTION (Table 1)

Since farmers decide on the basis of the herd how their livestock is to be fed, housed, and managed, the cow-calf herd was taken as the primary unit and most analyses were done at that level. The population of interest was all cow-calf herds in Ontario. Because of logistical constraints, those in Northern Ontario and with fewer than 25 cows in 1984 or 1985 were excluded. A list of 1444 breeding herds enrolled in the BHIP was used as the possible study group; after stratifying by region, 300 herds were selected at random from this list.

The 300 farms were contacted first in June, 1986. One hundred were visited first between July and November of that year while the remaining 200 were visited between February and June, 1987. The second round of visits was made between January and May, 1988.

The information on production required from all farms was the number of cows and heifers bred, culled, sold for breeding, or purchased and which had died, calved, and weaned a calf. The number of calves which survived to weaning was also mandatory information.

For producers who could identify events for individual cows, a herd inventory list was updated with information on culls, sales, deaths, and purchases. This list was prepared from BHIP information. Other information such as calf weaning weights, pregnancy diagnosis results, and artificial insemination data was photocopied at the farm using a portable photocopier. For comparison, weaning weight information, without personal identification, was also obtained for 66 herds which were not part of the study.

Farmers were asked to record disease statistics for all animals. During farm visits, they were also asked to recall for each disease category the number of animals affected, their identity, and when the disease occurred (if known). Disease categories were restricted to problems the farmer could identify readily.

All questions on management, housing, feeding, and disease prevention and control were obtained by inspection of the premises and by standard survey forms. All three interviewers pre-tested the protocol for these inspections and surveys on five farms to compare their interpretations of the farmers' responses.

A standard database management system, DBASE III PLUS, Ashton-Tate, was used throughout the project. Two summary files were kept on each herd, one from the 1986-1987 calving season, the other from the 1987-88 season. Each file contained the number of cows and heifers to whom the events and diseases of interest occurred during the specified period.

For each of the 150 herds which identified individual cows, separate cow and calf files were created containing the core information. The data were down-loaded directly from the BHIP database or were entered by hand from copies supplied by BHIP or the producer. Data analyses were performed using a variety of software packages, in particular Statistical Analysis System (SAS) and the BioMedical Data Program (BMDP). In analyses carried out on the individuals, adjustments were made, when possible, for clustering within the herd.

The health and productivity of cow-calf herds in Ontario were summarized by following a cohort of 7679 cows and 1269 heifers, and their calves, from 181-192 separate breeding groups in 171-181 herds selected at random from BHIP files. (Focusing on these groups makes it unnecessary to refer to the number of animals that entered or left the herd during the period. Since these numbers were nearly equal, the results were essentially the same whether these animals were accounted for or ignored.)

CURRENT MANAGEMENT OF COW-CALF HERDS IN SOUTHERN ONTARIO

Most cow-calf herds (90%) are managed by the owners who average 46 years of age and 18 years' experience with this type of farm. Of these owners, 30% have community college or university education and 35% have full-time employment off the farm.

The average herd was composed of 52 breeding females (recall that the minimum herd size studied was 25). The breeding herd took about 75% of a person-year to manage. Of these farms, 56% raised other livestock and 27% raised cash crops. Only 5% had full-time hired help.

The housing and feeding of the herds were consistent with a pasture-based spring-summer breeding season and a winter period during which the animals were housed and fed hay and/or silage as the main roughage. The peak calving month for these herds was April.

Only 14% of farms bred heifers earlier than cows, 8% 'flushed' their females before the breeding season, 20% used artificial insemination for breeding, and 51% of the herds had no particular breeding season; that is, the season was longer than six months. About 30% of owners had their females checked for pregnancy, 88% used no injectable vitamins, 64% no vaccines, and 25% no anti-parasitic biologicals. There were differences in the use of some of these measures among the four regions of Southern Ontario.

PRODUCTIVITY LEVELS AND DISEASE RATES

Overall productivity, as measured in kilograms of weaned calf per cow/year, varied widely between groups. For cow groups, values ranged from 72.4 kg to 318.8 kg; 25% of groups produced less than 160 kg (350 lbs) of calf per cow/year. On the other hand, the top 25% of groups produced more than 205 kg (450 lbs).

These variations in overall productivity levels among groups reflect variations in specific health and productivity rates. For example, heifers were more likely to calve or remain in the group than cows. If 80% is taken as a target rate for calving, over 74% of heifer groups and 63.5% of cow groups achieved the goal. The lower proportion of cow groups reaching a level of 80% calving reflects the generally higher culling rates for cows.

At calving, heifers had more difficulties than cows and there were three times as many stillbirths for the former. Some heifer groups had particular problems, with 14.5% of groups having stillbirth rates over 20%.

Heifers also required more assistance at calving. Almost 25% of heifers were assisted compared to 5.7% of cows. The pre-calving success of heifers compared to cows was offset by greater calving losses so that the overall rate of calves born alive to cows (80.2%) was close to that of heifers (80.8%). For heifers, sire breed type was the most important factor in determining assisted deliveries and stillbirths (Table 2).

Table 2: The relationship of assisted calving, dam breed type, sire breed type, region of the Province and calf sex with the frequency of stillborn calving in 713 first progeny beef heifers in Ontario.

	Stillborn[a]	Liveborn	Total	Stillborn Percent	Chi-square	p-value
Assisted	27	131	158	17.1		
Unassisted	23	532	555	4.1	29.6	0.000
Totals	50	663	713	7.0		
Dam Breed Type						
Large	11	173	184	6.0		
Medium	10	231	241	4.2		
Small	29	259	288	10.1	7.5	0.024
Totals	50	663	713	7.0		
Sire Breed Type						
Large	14	170	184	7.6		
Medium	6	186	192	3.1		
Small	30	307	337	8.9	6.4	0.041
Totals	50	663	713	7.0		
Region of Ontario						
Central	7	119	126	5.6		
Eastern	8	132	140	5.7		
Southern	7	92	99	7.1		
Western	28	320	348	8.1	1.3	0.72
Totals	50	663	713	7.0		
Calf Sex[b]						
Female	11	345	356	3.1		
Male	22	312	334	6.6	3.9	0.05
Totals	33	657	690	4.8		

a. refers to heifers experiencing a stillborn calving
b. not reported for 23/713=3.2% of calvings.

Overall calf mortality rates were low: 2.6% for calves from cows and 3.9% from heifers. Rates greater than 5% occurred in 16% of the cow groups and 14% of the heifer groups. Thus, the bulk of calf deaths took place in only a few groups.

These production and disease rates are useful summaries of a cow-calf herd's performance; however, to investigate factors influencing herd health and productivity, these broad outcome rates should be subdivided into their components. This is the topic of the following sections.

HEALTH, PRODUCTIVITY, AND MANAGEMENT OF CALVES

Producers are wary of averages and prefer to consider their herd as a unique operation. Using a percentile or graphic display to illustrate where the bulk of herds rank is more useful than taking a single value. The overall averages are fairly consistent from year to year, but, if the measures are stratified by Provincial region, one finds significant inter-regional trends that indicate the need for more detailed analyses.

Disease categories and periods of risk for calves were kept sufficiently general to be comprehensible to producers and at the same time detailed enough for useful statistical analyses. As a means of assessing validity, herd level data were compared with results compiled after lengthy checking of diaries for individual animals and other sources of information. Only 9% (13 of 137) of estimates on stillborn calves and 16% (22 of 137) of estimates on total dead calves disagreed where we considered the herd-level data to be valid.

The total mortality up to weaning for calves born alive was very consistent between 1986 (3.22%) and 1987 (3.16%). There were just over twice as many deaths in the newborn period (less than twenty-eight days of age) as in the period twenty-eight days to weaning. This was true in 1987 as well. Stillbirth rates were also very consistent between 1986 and 1987 (3.73% and 3.71%). In both years, 33% of the groups had no stillbirths. In 1987, the stillbirth rate for heifers (8.79%) was significantly higher than for cows (2.73%), herds in the eastern region had a significantly higher rate than did herds in the western and central regions, and heifers had a significantly higher rate of newborn calf mortality (3.53%) than did cows (1.84%).

The distribution of total calf mortality showed that less than 25% of the herds accounted for most of the deaths in both years. The situation is similar for diarrhea and pneumonia. In preliminary analyses, the factors associated with newborn deaths were calving location and region. The use of a barn with a yard as the primary calving location was associated with the highest number of deaths for newborn calves. The number of such deaths was higher in the western and central regions than in the southern and eastern.

Table 3: The relationship, indicated by the sign of regression coefficient, between selected, independent variables and outcomes in the heifer part of the herd

		Outcomes Studied							
Variables Included	Mean Rate	CR	LCR	WCR	AR	SR	CMR	CWW	WHE
Herd size	61				–	+			
Breed Composition	1.9	–			+			+	+
Region: Southern							+		
Experience Farming	23					+			
Works Off Farm	32	+	+	+					+
Bred Earlier	17				+				
To Calve at 2 Yrs.	84	+							
Specific Mating Period	60		–	–			–	–	–
Bull Smaller Calves	58		+	+		–			+
Number Bulls Used	1						–		+
Grain Post-yearling	67						+		
Flushed Pre-breeding	32	+					–	–	
Salt/Mineral Breeding	95		–					+	
Grain Post-breeding	33		+	+		–		+	+
Grain at Calving	22						+	–	
Calving Pen	19				+			+	+
More Observation	72				+	+			–
Different Location	38			+		–	–		
Calving Age	808						–	–	–
Herd Median Day	54							+	
Herd Calving Spread	158							–	
Heifer Median day	37		+				+		+
Heifer Calving Spread	92							+	

CR=calving rate, LCR=liveborn calving rate, WCR=weaned calf crop rate, AR=assisted rate, SR=stillborn rate, CMR=calf mortality rate CWW=calf weaning weight, WHE=calf weight weaned per heifer exposed.

Total morbidity rates for diarrhea were consistent between 1986 (9.4%) and 1987 (11.0%) as were those for pneumonia: 3.85% in 1986 and 4.0% in 1987. The frequency of illness from diarrhea was highest in the newborn period and from pneumonia in the period from twenty-eight days to weaning. There were no significant differences in the specific illness rates of calves from cows as compared with those from heifers.

Twenty-five percent of the groups had an actual weaning weight greater than 239.3 kg and an adjusted weight greater than 269.9 kg. Both these measures were highly variable between groups, especially between groups of heifers. Actual weaning weights were not significantly different across regions, but there was a significant trend towards higher adjusted weights in herds from the eastern region.

The majority of the breeding females calved in April, May, and June. Only 10% of producers had the peak calving time during the last six months of the year. About half the producers overwinter cattle in the main calving location.

Farmers changed the frequency with which they observed livestock from 8% who checked females due to calve at least once a day to 57% who checked the cow-calf pair less than once a day when the calves were at least a month old.

Approximately 45% of farmers castrate calves under one month of age and about 43% either dehorn in this period or raise polled calves. The most common vaccines used on calves were IBR/PI3 and Clostridial sp., but 40% of producers were not using vaccines. Twenty-two percent of farmers did not treat the calves with any anti-parasitic.

About one-quarter of the farms were pre-conditioning over 75% of their calves and were members of the Ontario Certified Pre-conditioned Calf Program. The participation of individual herds in this program varied from year to year. For example, only about one-third of farms pre-conditioning calves in 1987 were participants since 1985. About 50% of producers who pre-conditioned their calves in 1986 did not do so in 1987. In 1986, 59% and in 1987, 67% of producers kept over 50% of their weaned calves for meat or breeding replacements.

Further analyses are planned to examine the association of weaning weight, mortality, and morbidity with a number of herd and individual factors.

PERFORMANCE OF BEEF HEIFERS: ANALYSES OF INDIVIDUAL ANIMALS

Growth, reproductive performance, and frequency of disease were studied for 756 beef heifers in 76 herds. Each herd had at least five heifers bred in 1986.

The average adjusted weaning and yearling weights for the heifers were 242 kg (534 lbs) and 357 kg (788 lbs) respectively. Both weaning and yearling adjusted weights were greater for heifers selected as herd replacements compared to those culled or sold from the herd. This indicates that weight, or size, was used as a selection criterion. However, adjusted weaning and yearling weights of those heifers were not significant determinants of the rates for calving, live-born calving, weaned calf crop, stillborn calves, or assisted calving, nor for weaning weights of their first progeny.

The heifers' average age at calving was 2.2 years. An increase of one pound in adjusted yearling weight decreased the age at which the animal calved by an estimated 0.304 days with yearling weight explaining 1.14% of the total variation. Calving age had a negative effect on weaning weight of first progeny, explaining 1.07% of the variation, with the weaning weight decreasing an estimated 0.085 kg (0.187 lbs) for each day increase in calving age. The average weaning weight for first progeny was 241.3 kg (532 lbs). The adjusted weaning weight of calf per heifer mated was 205.9 kg (454 lbs).

For heifers, the calving rate was 95%, live-born calving rate 88%, and net weaned calf crop 86%. The stillborn rate was 7.3%, mortality rate 2.0%, and total calf wastage 9.1%. Twenty-two percent of calvings were assisted and an assisted calving was 4.5 times more likely to be stillborn.

Sixteen percent of heifers were culled with most culling carried out after calves were weaned. The probability of a heifer being culled for emergency reasons was 0.018, for failure to perform 0.076, and for other reasons 0.076. The 6% frequency of disease was considered lower than the population rate because every occurrence was not recorded. We believe, however, that this frequency is not a gross underestimate of disease occurrence. Reproductive diseases were most frequent (65%) in proportion to all the disease reported. A prolapsed uterus followed 2% of the calvings, and 57% of these heifers were culled and not afforded another opportunity to calve. Fully 50% of heifers either were culled or died following reproductive disease.

WEANING AND YEARLING WEIGHT AS DETERMINANTS OF HERD PERFORMANCE IN REPLACEMENT BEEF HEIFERS

The adjusted weaning and yearling weights of replacement heifers were examined as determinants of reproductive performance, calf survival, first progeny growth, and productivity at the herd level. After confounders in the analyses were identified and controlled, we found that weaning and yearling weights were neither negative nor positive indicators of calving, live-born calving, weaned calf crop, assisted or stillborn calving, or calf mortality rates in the study herds.

The weaning weight of heifers was a significant determinant of first progeny weaning weight which is similar to the individual heifer-progeny weight relationship. The weaning weight of replacement heifers explained 4.4% of the variation in first progeny weaning weight by herd. Some management practices probably contributing in a positive way to the observed weaning weight of first progeny include avoiding a specific mating period, supplementing feed with salt and mineral during the breeding period, feeding grain in the post-breeding period, and using a calving pen.

The weaning weight of replacement heifers was a significant determinant of herd productivity and explained 3.7% of the variation in calf weight weaned per heifer mated. Management practices likely contributing in a positive way to the observed herd productivity are mating to bulls known to leave smaller calves, exposing to more than one bull, avoiding both a specific mating period and extra observation at calving time, and feeding grain in the post-breeding season.

With the exception of the heifer data, most of the results presented here are descriptive. Analytical models to explain these results are being developed, as are models to guide decisions about culling. The future statistical models to predict herd productivity should be beneficial to the Ontario beef industry.